

OPERATING EXPERIENCE WEEKLY SUMMARY

Office of Nuclear and Facility Safety

February 19 - February 25, 1999

Summary 99-08

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EVENTS

1. WORKER INJURED BY FALLING POWER AND DATA CABLES

On February 8, 1999, at the Waste Isolation Pilot Plant (WIPP), a worker was struck on the shoulder by de-energized power and data cables falling from the roof of the WIPP underground. The injured worker was part of a three-man crew temporarily relocating the cables to accommodate other work in the underground. The crew had relocated approximately 200 feet of cable when one of the cable hangers failed, and the additional load on adjacent hangers caused them to fail in sequence until all 200 feet of cable had fallen. Investigators believe that the hangers failed because the crew attached them in a way that effectively doubled the design load on the hanger. Medical personnel determined that the worker's injuries were minor and they allowed him to return to work. No one had conducted an engineering evaluation or hazard analysis of the temporary modification to the cable support system, and the result was minor injuries to one employee with the potential for very serious injury to nearby workers. (ORPS Report ALO--WWID-WIPP-1999-0002)

Investigators estimated that the cables weighed approximately 15 to 20 pounds per foot and that they fell approximately 15 feet. They determined that the three-man crew relied on skill-of-the-craft to safely relocate the cables. The permanent support system consisted of a steel cable suspended from the roof of the underground. The cable hangers, referred to as spring clips, encircled the cable bundles at engineered intervals and the ends of the spring clips were hooked over the steel cable. The crew unhooked both ends of each spring clip from the permanent steel cable and relocated each clip by hooking only one end of it onto nearby rock bolt plates. The weight of the cables was sufficient to straighten the end of the spring clips, and the cables fell. The facility manager suspended work in the area, appointed a root cause investigation team, and ordered that the fallen cables be reattached to the permanent support system. Figure 1-1 shows one of the failed spring clips.



Figure 1-1. Failed Spring Clip

NFS has reported similar events where the work control process failed to adequately address job hazards in several Weekly Summaries. Following are some examples.

- Weekly Summary 98-13 reported that two electricians at the Los Alamos National Laboratory Accelerator Complex received burns to their hands and faces when vapors from an aerosol electrical contact cleaner they were using contacted an electrical space heater, ignited, and formed a fireball. They were using the cleaner while performing maintenance on two electrical transformers. Investigators determined that use of a space heater was not specified in the work package and that no one performed a chemical hazard analysis before the electricians began work. (ORPS Report ALO-LA-LANL-ACCCOMPLEX-1998-0005)
- Weekly Summary 97-08 reported that a welder at the Oak Ridge K-25 Site was fatally injured when his anticontamination clothing and coveralls caught fire. The welder was using a cutting torch in a contaminated cell area and was wearing multiple layers of protective clothing, a respirator, and a welder's mask. A Type A Accident Investigation Board found that concerns regarding the contamination hazard may have caused the use of a level of protective equipment that impeded the welder's response to the actual, but unrecognized, hazard of clothing ignition. (ORPS Report ORO--LMES-K25GENLAN-1997-0001, and *Type A Accident Investigation Board Report on the February 13, 1997, Welding/Cutting Fatality at the K-33 Building, K-25 Site, Oak Ridge, Tennessee*)

These events underscore the importance of pre-job planning. While it is appropriate to exclude certain routine work from formal control, supervisors should recognize that temporary changes to permanent engineered systems require work controls commensurate with the potential hazards. Managers must ensure that integrated safety management systems are effectively implemented. The objective of integrated safety management systems is to incorporate safety into management and work practices by addressing all types of work and all types of hazards to ensure safety for workers, the public, and the environment.

Facility managers should review the following references for guidance on work control and integrated safety management.

- DOE O 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*, states that the contractor must identify workplace hazards and evaluate the risk of associated worker injury or illness.
- DOE G 450.4-1, *Integrated Safety Management System Guide for Use with DOE P 450.4 Safety Management System Policy*, describes the principles and functions that must be addressed in an effective integrated safety management program. The five core functions of DOE's integrated safety management system are (1) define the scope of work, (2) identify and analyze the work hazards, (3) develop and implement hazard controls, (4) perform work within controls, and (5) provide feedback on the adequacy of controls and continuous improvement in defining and planning work.
- DOE O 4330.4B, *Maintenance Management Program*, section 8.3.1, provides guidelines on work control systems and procedures. The order states that work control procedures help personnel understand the necessary requirements and controls.

Integrated safety management information can be found at the Safety Management website, <http://tis-nt.eh.doe.gov/ism>.

KEYWORDS: underground, safety analysis, work planning

FUNCTIONAL AREAS: Industrial Safety, Work Planning

2. SUBCONTRACTOR HITS AND RUPTURES A NATURAL GAS LINE

On February 4, 1999, at the National Renewable Energy Laboratory (NREL), a construction subcontractor operating a track-hoe struck and ruptured a 2-inch natural gas distribution line. The subcontractor immediately stopped work, shut down his equipment, and evacuated the work area. He had failed to follow a project manager's instructions as to the excavation boundaries and was working in an area that should have been excavated by hand. Although no injuries occurred and the gas did not ignite, ruptures of active gas lines have the potential to cause injury, fatalities, equipment damage, or process interruptions. (ORPS Report CH-NA-NREL-NREL-1999-0001)

The construction subcontractor was trenching to allow the installation of communication lines between two buildings. The gas line had been installed only a year earlier and was buried approximately 3.5 feet. After the line was struck, the contractor immediately notified NREL's Site Entrance Building. Personnel in the Site Entrance Building activated the NREL Emergency Notification System, which notified a local fire and rescue team and the public service company, owner/operator of the gas line. NREL's Environment, Safety and Health personnel and Site Operations personnel went to the scene, established a perimeter around the area of the leak, and set up roadblocks to prevent access. Firefighters deployed with gas detection equipment and ordered a precautionary evacuation of two facilities. Public service company workers arrived and capped the leak.

Investigators determined that workers had earlier hand-dug down and found the unexpected 2-inch line, which ran parallel to a 20-inch gas line. The NREL project manager instructed the subcontractor to excavate east of the gas line and not to go within 5 feet of the line. Ignoring this instruction, the subcontractor decided to go outside the established boundaries. He was in a hurry to complete the excavation as the shift would soon end and the rented equipment was due to be returned early the next morning.

Investigators also determined that the public service company did not provide NREL with as-built drawings, which would have shown the 2-inch line, following the installation of a 20-inch line through the NREL site. Also, utility locators did not find the buried 2-inch line because the electrically conductive tracer wire that aids in locating such lines either was never installed or somehow became broken.

NFS has reported other gas line ruptures during excavation work in the Weekly Summary. Some examples follow.

- Weekly Summary 98-34 reported that a trenching machine operator struck and severed a 1-inch natural gas pipeline at the Los Alamos National Laboratory. Investigators determined that the construction contractor did not carry out the work in accordance with contract provisions because he did not maintain a red-line drawing at the work site that showed underground utilities relative to site benchmarks. Also, he did not direct workers to excavate by hand within 5 feet of utilities and did not consult site utility locator personnel before excavation began,

as required by the activity hazard analysis. (ORPS Report ALO--LA-LANL-ADOADMIN-1998-0005)

- Weekly Summary 97-44 reported that a construction worker at the National Institute for Petroleum and Energy Research severed a 2.5-inch natural gas line with a trenching machine, resulting in evacuation of the area. Investigators determined that the as-built drawings incorrectly identified the line depth. Investigators also learned that this was the third gas line ruptured during excavation activities that year. The other events included the following: (1) workers hit and ruptured a 1-inch natural gas line while excavating and (2) a contractor ruptured a 3-inch natural gas line while demolishing a building. Again, construction drawings did not show the correct location of the pipelines. (ORPS Report HQ--GOPE-NIPER-1997-0005)

Natural gas explosions can cause significant damage and loss of life. On December 11, 1998, in St. Cloud, Minnesota, workers attempting to lay a fiber optic cable cut a gas main, resulting in an explosion. The blast leveled three buildings, killed 4 people, and injured 10 others. Bureau of Labor Statistics data on construction-related occupational injuries show that in 1996, 50 fatalities were attributable to excavation work. Figure 2-1 shows a 1989 event at Lebanon, Missouri, in which an operator was killed when his road grader struck a 10-inch propane pipeline.



Figure 2-1. Propane Line Severed¹

OFAF engineers searched the ORPS database for reports of events that involved hitting gas lines during excavation and found 35 reports. The complete database was searched using All Narrative with a search string containing (natural gas OR gas line) AND (trench* OR excavat* OR dig*). The distribution of root causes was as follows: (1) management problems accounted for 43 percent; (2) procedure problems, 20 percent; and (3) personnel error, 11 percent.

In most cases, trenching and excavation activities are performed by subcontractors, which makes it more important to have good communication and subcontractor control. If subcontractors are responsible for locating utilities before digging, they should demonstrate to facility management that underground utilities have been located, identified, and marked before excavation begins. Construction supervisors and project managers should review the following documents related to excavation activities.

- OSHA 29 CFR 1926, *Safety and Health Regulations for Construction*, subparts .651(b) and .651(a)(3), make employers responsible for identifying underground

¹ *Underground Focus Magazine* (Spooner, Wisconsin, Canterbury Communications); taken from <http://www.underspace.com>.

hazards near a work area. 29 CFR 1926.965(c) requires that work must be conducted in a manner to avoid damage to underground facilities. Similarly, work must be performed in a manner that provides protection to the workers.

- DOE/EH-0541, Safety Notice 96-06, *Underground Utilities Detection and Excavation*, provides descriptions of excavation events, an overview of current technology for underground utility detection, specific recommendations for improving site utilities detection and excavation programs, and information on innovative practices at DOE facilities. It states that a central coordinator should not only assist in identifying underground utilities but should also record the findings. It can be obtained by contacting the ES&H Information Center, (800) 473-4375, or by writing to ES&H Information Center, U.S. Department of Energy, EH-72, 19901 Germantown Rd., Germantown, MD 20874. Safety notices are also available on the OEAF home page at http://tis.eh.doe.gov:80/web/oeaf/lessons_learned/ons/ons.html.

KEYWORDS: construction, excavation, gas line, underground, utility

FUNCTIONAL AREAS: Construction, Industrial Safety

3. UNEXPECTED EXTREMITY EXPOSURES AT SAVANNAH RIVER

On February 4, 1999, four laboratory technicians at the Savannah River Laboratory Technical Area received unexpected extremity exposures while they were preparing a sludge sample for analysis. Working in a radiological hood, one of the technicians had removed the sample from a small glass vial that had been packaged in two polyethylene bags inside a one-gallon metal can. When he finished processing the sample, he asked a radiological control inspector to survey the prepared sample and attach the proper labels. The inspector detected extremity dose rates from the sample, the glass vial, and filter equipment that exceeded the standing radiological work permit suspension limit of 500 mrem/hour. The largest calculated extremity dose among the technicians who had handled the open sample was 1,478 mrem, which is well below the DOE annual extremity dose limit of 50,000 mrem. However, this occurrence is significant because it resulted in radiation exposures that were unplanned and unanticipated. (ORPS Report SR--WSRC-LTA-1999-0004)

Laboratory personnel immediately stopped work on the sample, capped the sample vial, and placed the vial and filter equipment at the back of the hood. They tagged the prepared sample that had been removed from the hood and placed it in a radioactive materials area. Health physics personnel processed whole-body dosimetry for laboratory personnel with no unusual readings. They calculated extremity exposures based on radiation measurements and analysis of the sample preparation task.

The facility manager initiated an investigation of this occurrence, and investigators determined the following.

- A specific gravity instrument for a waste evaporator at F-Canyon had experienced a plugging problem. Engineers who were troubleshooting the problem requested an analysis of the composition of solids in the evaporator bottoms, particularly for the presence of carbon.
- On January 20, personnel at F-Canyon drew five samples from the highly radioactive evaporator bottoms. They sent two of the samples to a laboratory at F-Area for initial processing. During this initial processing, laboratory personnel

"washed" the samples to remove soluble constituents and to reduce overall activity.

- On January 25, F-Canyon laboratory personnel placed a 10-ml vial of washed sample suspension into a one-gallon paint can and surveyed the can. They placed a "Caution - Radioactive Material" label on the outside of the can that indicated 4 mrem/hour on contact. They then transferred the can containing the sample to the Laboratory Technical Area.
- On February 4, a Laboratory Technical Area technician opened the can inside a radiological hood, poured the contents of the sample vial through a filter vessel, and transferred some of the solids collected on the filter to a sample slide. When the technician transferred the slide from the hood, he noticed elevated counts from a nearby count-rate meter. He asked a radiological control inspector to place a caution tag on the sample slide.
- The radiological control inspector detected 1,600 mrem/hour of beta from the finished sample, 100,000 mrem/hour of beta at the top of the filter vessel, and 1,280 mrem/hour beta from the glass vial containing sample residue. Whole-body penetrating radiation dose rates ranged from none detected to 1 mrem/hour.

When they were drawn from the evaporator bottoms, the samples had a heavy burden of radioactive strontium-90 and its decay product, yttrium-90. Strontium-90 decays to yttrium-90 with a long half-life and emits a relatively soft, easily shielded beta particle of approximately 0.5 MeV. Yttrium decays with a short half-life and emits a very energetic beta particle of approximately 2.2 MeV. In addition, yttrium is approximately 500 times more soluble in water than strontium. Investigators believe that washing the sample at F-Area removed most of the yttrium-90 and left most of the strontium-90. This accounts for the very low dose rate observed at the surface of the can shortly after the sample was washed and packed. Over the 10 to 15 days that elapsed between washing of the sample and its final preparation, a significant amount of strontium-90 had decayed to yttrium-90, which accounts for the high activities measured at the Laboratory Technical Area.

This occurrence underscores the importance of exercising special caution when processes are changed or when new processes are introduced. Personnel at the Laboratory Technical Area are very familiar with the characteristics and hazards of the samples they normally process. However, the preprocessing of the sample in question to remove soluble components radically changed its characteristics. No one had surveyed the sample between the time it was surveyed and packaged at F-Area and the time that the Laboratory Technical Area technician requested a survey of the finished sample. Laboratory procedures do not require such surveys. The technician relied on the radiological postings on the one-gallon can and treated the contents accordingly, unaware that the radiological characteristics of the sample had changed significantly. DOE/EH-0256T, *U.S. Department of Energy Radiological Control Manual*, states in paragraph 303 that at facilities with routine, recurring process operations, managers should give special attention to radiological activities that are infrequently conducted or that represent first-time operations. Planning for such activities should include the following.

- Formal radiological review.
- Review by senior managers with a view to anticipating concerns and specifying protective measures.
- Review and approval by the ALARA committee.

- Enhanced line and radiological control management oversight during initiation and conduct of the work.

KEYWORDS: extremity exposure, radiation protection, radioactive material, laboratory

FUNCTIONAL AREAS: Radiation Protection

4. **ELECTRICIAN RECEIVES FLASH BURNS WHILE TROUBLESHOOTING ENERGIZED EQUIPMENT**

On February 15, 1999, at Sandia National Laboratory—New Mexico, a facilities maintenance electrician caused a short circuit and received electrical flash burns to his left hand and right finger while troubleshooting an energized 120/208-V ac power strip. In addition, flying hot metal particles from the short circuit caused a fire in a nearby stack of paper. The power strip was part of a prewired modular office-partition baseboard power strip. The electrician was testing the power strip voltage to isolate and determine the cause of an intermittent loss of power when his voltmeter test leads contacted two-phase connector contacts, causing the phase-to-phase short circuit. He was not wearing safety glasses or gloves while troubleshooting the power strip. Emergency responders extinguished the fire and transported the electrician to the Sandia medical department, where medical personnel treated him for first- and second-degree burns, administered an electrocardiogram and a vision test, and sent him home for the remainder of the day. Because the troubleshooting activities were associated with modular office furniture, facility personnel underestimated the electrical hazard involved and did not implement the necessary work controls to ensure the work was completed safely. (ORPS Report ALO-KO-SNL-NMFAC-1999-0002)

Investigators determined that the electrician was using a generic work order to troubleshoot intermittent power losses and that the work order did not require him to lock out or tag out the power strip. He had traced the problem to two receptacles in the office partition and was attempting to measure the voltage. He turned slightly to look at the voltmeter and accidentally moved the test probes, causing the short circuit. The power strip connector contacts are approximately one-eighth of an inch apart. Investigators also determined that the low voltage electrical standard operating procedure requires workers to wear safety glasses during troubleshooting activities. However, it permits workers to forego wearing insulated gloves if they determine gloves hinder their manual dexterity. Figure 4-1 shows the burns on the electrician's left hand.



Figure 4-1. Burns on Electrician's Left Hand

Investigators determined that the power strip was not insulated between the connector contacts so the power strips from adjoining office partitions could be plugged together. Investigators also determined that the manufacturer recommends that when defects are suspected in the power strips, resistance testing should be performed instead of voltage testing. The manufacturer also recommends that the strips be de-energized before any testing or work is performed on them. Facility personnel were unaware of these recommendations until after the short circuit.

Figure 4-2 shows an undamaged power strip connector contacts. Figure 4-3 shows the power strip connector contacts after the short circuit.



Figure 4-2. Undamaged Power Strip Connector Contacts



Figure 4-3. Damaged Power Strip Connector Contacts

NFS has reported similar accidents while personnel were working near energized equipment. Some examples follow.

- Weekly Summary 98-50 reported that an electrical engineer at the Rocky Flats Environmental Technology Site Broomfield Warehouse accidentally contacted an inadequately wrapped, bolted 480-V cable connection with a clamp-on ammeter, causing an electrical arc and a blown fuse in the power distribution panel. The engineer was measuring current flow in surrounding components and was attempting to attach the ammeter when he contacted the cable connection and caused it to contact a metal wireway. Investigators determined that because the warehouse is off-site and is not a DOE facility, no one implemented the necessary work control programs or safety measures. (ORPS Report RFO--KHLL-371OPS-1998-0085)

- Weekly Summary 98-35 reported that a subcontractor electrician at the Rocky Flats Environmental Technology Site Plutonium Processing and Handling Facility observed an electrical arc from a primary-phase winding connection on an energized 480-V, three-phase transformer to a ground-strap while he was working on the transformer. The arc left burn marks on the electrician's protective glasses, but he was not injured. Investigators believe that material the electrician was removing from the area accidentally contacted a ground-wire lug, causing the arc. (ORPS Report RFO--KHLL-371OPS-1998-0065)

These events underscore the importance of using an integrated approach to safety that stresses clear goals and policies, individual and management accountability and ownership, implementation of requirements and procedures, and thorough and systematic management oversight. The responsibility for work planning and control activities resides with line managers, who should ensure that these processes are followed and facility policies and procedures are enforced. Safety and health hazard analyses must be included in the work control process to help prevent worker injury. The hazard analysis process should include provisions for lockouts/tagouts, job-specific walk-downs, integration of work activities, and personal protective equipment. Pre-job briefings, facility procedures, and training programs should emphasize the dangers associated with electrical activities.

In the Sandia event, work controls and documentation for electrical work were inadequate to satisfy the five core functions of DOE's integrated safety management system: (1) define the scope of work, (2) identify and analyze the work hazards, (3) develop and implement hazard controls, (4) perform work within controls, and (5) provide feedback on the adequacy of controls and on defining and planning work. Because no one obtained or reviewed the manufacturer's recommendations for the panels, work and safety requirements were not defined, the job mission was not translated into safe work practices, and safety expectations were not set.

Personnel at DOE facilities should have a continually questioning attitude toward safety issues. Each individual is ultimately responsible for complying with rules to ensure personal safety. Facility managers should communicate the idea that safety is of prime importance and that all personnel must be committed to excellence and professionalism.

Facility managers, work planners, and crafts personnel should review the following references, which provide guidance and good practices for planning electrical work.

- 29 CFR 1910, *Occupational Safety and Health Standards*, and DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities*, provide guidance on the implementation of effective lockout/tagout programs. Both state that the primary purpose of a lockout/tagout program is to protect personnel from injury and protect equipment from damage. 29 CFR 1910, subpart S, "Electrical," describes work practices to prevent injuries when work is performed near or on equipment or circuits that are, or may be, energized.
- DOE-STD-1120-98, *Integration of Environment, Safety, and Health into Facility Disposition Activities*, provides guidance for enhancing worker, public, and environmental safety. This standard supports integrated safety management system principles, which include (1) line management responsibility for safety, (2) clear roles and responsibilities, (3) competence commensurate with responsibilities, (4) balanced priorities, (5) identification of safety standards and requirements, (6) hazard controls tailored to work being performed, and (7) operations authorization.
- DOE-STD-1030-96, *Guide to Good Practices for Lockouts and Tagouts*, section 1, "Introduction," states that the primary purpose of lockout/tagout programs is to

protect employees from exposure to potentially hazardous energy sources. This standard also states that lockout/tagout programs promote safe and efficient operations and are an important element in the conduct of operations programs.

- DOE/ID-10600, *Electrical Safety Guidelines*, prescribes electrical safety standards for DOE field offices and facilities. It includes information on training and qualifications, work practices, protective equipment, insulated tools, and recognition of electrical hazards. Section 2.13.1.3 states that when circuits and equipment are worked on they must be disconnected from all electrical energy sources.
- DOE/EH-0557, Safety Notice 98-01, *Electrical Safety*, contains summaries of electrical events along with corrective actions and recommendations related to them. It concludes that personnel error was the direct cause of approximately half of all electrical occurrences, and it lists failure to de-energize equipment, failure to correctly lock and tag equipment out of service, and failure to perform zero-energy checks as major contributors to personnel error.

Integrated safety management information can be found at <http://tis-nt.eh.doe.gov/ism>. OSHA regulations are available at http://www.osha-slc.gov/OshStd_data. DOE standards are available at <http://tis.eh.doe.gov/html/techstds/standard/standard.html>. Safety notices can be obtained by contacting the ES&H Information Center, (800) 473-4375, or by writing to U.S. Department of Energy, ES&H Information Center, EH-72, 19901 Germantown Rd., Germantown, MD 20874. Safety notices are also available at http://tis.eh.doe.gov:80/web/oeaf/lessons_learned/ons/ons.html. The *Hazard and Barrier Analysis Guide* discusses electrical hazards and is available from the ES&H Information Center or at <http://tis.eh.doe.gov:80/web/oeaf/tools/hazbar.pdf>.

KEYWORDS: electrical, work control, injury, burn

FUNCTIONAL AREAS: Industrial Safety, Hazards Analysis, Work Control

5. PLUTONIUM CHECK SOURCE FOUND IN LOCKER ROOM

On February 12, 1999, at the Rocky Flats Environmental Technology Site, a radiological control technician discovered a plutonium-239 check source inside a box in a men's locker room. Facility personnel had recently removed the box from another area of the locker room and placed it in the locker room hallway for disposition. The technician was walking by and noticed what he believed was a source inside the box, so he notified the building configuration control authority and they confirmed his belief. The technician surveyed the source and measured 7,434 dpm alpha. He also determined that there was no loose surface contamination. The technician bagged the source and stored it in the facility lockbox with other sources. All sources, whether they are accountable or exempted, are radioactive material and must be controlled in accordance with DOE radiological protection control requirements. Failure to account for and monitor sealed sources can result in source integrity being compromised and can lead to the spread of contamination and personnel exposure. (ORPS Report RFO--KHLL-771OPS-1999-0011)

Investigators determined that the source had been located inside the box in the locker room since at least 1994 and was not registered in the sealed source registrar. The facility manager held a fact-finding meeting on this event. Meeting attendees learned that although the source

was not an accountable source when it was originally received on site, it is now required to be controlled as an accountable source because requirements have changed over the years. The facility manager is considering withdrawing the ORPS report on this event because the source was not originally an accountable one. He also determined that because the facility is undergoing decontamination and decommissioning, it is expected that sources will be found and that no corrective actions are necessary.

A sealed radioactive source is radioactive material contained in a sealed capsule or attached to a nonradioactive surface to prevent material dispersion under accident conditions. Accountable sealed sources have a half-life greater than or equal to 30 days and activity levels greater than or equal to those listed in Appendix B of DOE Implementation Guide G-N 5400.9/M1-Rev.1, *Sealed Radioactive Source Accountability and Control*. Accountable sources are subject to an inventory program that tracks them and an integrity testing program, in addition to other requirements. Sealed sources that do not meet the criteria for an accountable sealed source are exempted sources. Exempted sources are not subject to the inventory program and the integrity testing program requirements, but they are not exempt from radiation protection controls.

OEAF engineers searched the ORPS database for radioactive source events that have occurred at Rocky Flats since January 1, 1998, and found 15 events. Some examples follow.

- On February 4, 1999, the facility manager reported that the physical location of a 0.8541 μCi sealed source could not be confirmed. Facility personnel were performing a semiannual inventory when they noticed that inventory documents indicated the source was in two different locations. The facility manager also reported that this event was not reported to ORPS until February 18, because Bechtel-Jacobs managers, Safe Sites of Colorado managers, and Rocky Mountain Remediation Services managers could not determine which company had responsibility for the facility. A radiological source program administrator turned the issue over to DOE for resolution. Rocky Mountain Remediation Services managers eventually accepted responsibility for the facility and categorized the event. Facility personnel later discovered that the source was properly stored inside a building source locker. (ORPS Report RFO--KHLL-771OPS-1999-0013)
- On April 21, 1998, a team lead discovered a locked wooden box that contained a 100-gram plutonium oxide standard. This violated the facility basis-for-operation because storage of nuclear materials was limited to low-level waste packaged in approved containers. Facility personnel moved the standard into an approved storage location. Investigators determined a new authorization basis had been implemented in the facility on February 2, 1998, and that this violation occurred because the new basis was inadequately implemented. Investigators discovered 28 more sources while verifying facility compliance with the basis-for-operation. (ORPS Report RFO--KHLL-771OPS-1998-0018)
- On April 14, 1998, a radiological technician discovered six check sources in abandoned personal lockers in a building hallway. The technician unlocked and opened the lockers to survey them so facility personnel could dispose of them. Investigators determined that five of the sources were plutonium and one was americium and that the sources had been stored inside the lockers since at least 1985. They also determined that the sources were not registered in the sealed source registrar. Investigators determined that in the 1980s, radiological technicians stored sources in personal lockers for use as instrument response

check sources and that this practice is no longer permitted. Corrective actions included registering the sources, searching additional lockers to ensure they did not contain check sources, and informing other facilities of this event at a Center of Expertise meeting.

These events highlight the need for comprehensive corrective action programs. The February 12, 1999, event could have been prevented if corrective actions from the April 14, 1998, event had been implemented sitewide in facilities that use, or have used, sealed sources. When deficiencies are identified and their root causes determined, corrective actions should be developed and evaluated to determine if they are applicable at other locations or if they apply to other programs or organizations. When the extent of the corrective actions has been determined, the actions should be assigned to the responsible organizations and tracked to completion for all locations, programs, or organizations that have the potential to be affected. Corrective actions are effective only if they preclude repetition. Inadequate corrective actions will result in repeat occurrences, some of which could endanger the health and safety of workers or the public. DOE contractors who operate nuclear facilities and fail to implement corrective actions for identified deficiencies could be subject to Price-Anderson civil penalties under the work processes and quality improvement provisions of 10 CFR 830.120, *Quality Assurance Requirements*.

Effective development and implementation of lessons learned programs are part of a successful corrective action program. Managers should ensure that lessons learned are developed when needed, distributed to the relevant personnel, and implemented. Lessons learned are valuable only if the information they communicate is used. Managers should review the following standards and determine if their programs include the guidance contained in them.

- DOE-STD-7501-95, *Development of DOE Lessons Learned Programs*, was designed to promote consistency and compatibility across programs.
- DOE-STD-1010-92, *Guide to Good Practices for Incorporating Operating Experiences*, states: "The use of experience gained should provide a positive method that a facility can use to improve their operations, making them efficient, cost-effective, and safe to the employees, the public, and the environment."

Links to DOE radiation protection documents, including a sealed source position paper, can be found at <http://tis-nt.eh.doe.gov/wpphm/regs/regs.htm>. The NRC maintains a sealed source database at <http://www.nrc.gov/NRC/FEDWORLD/NRC-SSD/index.html>. This database provides a list of sealed sources licensed by the NRC and a variety of information on sealed sources.

KEYWORDS: conduct of operations, personnel error, procedures, subcontractor, accountability, sealed source

FUNCTIONAL AREAS: Licensing/Compliance, Radiation Protection

6. CORRECTIVE ACTIONS FAIL TO PREVENT RECURRENCE OF SUBCONTRACTOR LOCKOUT/TAGOUT VIOLATIONS

On February 17, 1999, at the Idaho National Engineering Environmental Laboratory Test Reactor Area, the facility manager reported that a subcontractor employee violated lockout/tagout procedures on February 16, 1999, and that this violation was similar to one that occurred at the same facility on November 3, 1998. In both events, the systems were locked out and tagged out, but the lockout/tagout was the last barrier in place to prevent exposing workers to hazardous

conditions. Also, in both events subcontractor personnel failed to review lockout/tagout record sheets and installed their personal locks on the wrong lockboxes. Investigators determined that the corrective actions from the November 3 event failed to prevent the February 16 event. Failure to adhere to procedures and established lockout/tagout programs can place personnel, equipment, and the environment at risk. (ORPS Report ID--LITC-TRA-1999-0007)

In the February event, a subcontractor employee installed his personal lock on the wrong lockbox and began to drain the caustic acid lines of the facility day tanks system in preparation for decontamination and decommissioning. While reviewing the scheduled activities for the day, a utility area coordinator and a senior supervisory watch employee noticed that there were no personal locks hanging on the lockbox for the day tanks system. The coordinator reviewed lockout/tagout record sheets and determined that the subcontractor employee had installed his personal lock on the wrong lockbox. The coordinator informed him of the mistake and the subcontractor employee moved the lock to the correct lockbox but failed to remove the key from the lock after he had installed it on the correct lockbox. When the coordinator noticed the error, he exercised his stop work authority and notified the construction coordinator of the event. Although no one was exposed to hazardous conditions, personal locks were not in place to prevent facility personnel from placing the system in service while subcontractor personnel were working on it.

In the November event, subcontractor personnel installed a personal lockout/tagout on the wrong lockbox for an electrical system on cooling tower fans. They had initially installed the lockout/tagout on the correct lockbox but removed it over a weekend because they were not performing any work. Later that weekend, operations personnel initiated a lockout/tagout so they could test the system variable frequency drive units. When subcontractor personnel returned to work they did not review the lockout/tagout record sheets and reinstalled their personal lock on the lockbox that had been issued to operations personnel for testing the variable frequency drive units. Investigators determined that a weakness existed in identifying and mitigating construction work hazards. (ORPS Report ID--LITC-ATR-1998-0023)

The facility manager held a critique on the February 16 event. Critique members identified that the corrective actions from the November 3 event were not effective in preventing a recurrence. Those corrective actions included directions to integrate the construction short-range schedule and the construction safe work permit process and to ensure that subcontractors comply with lockout/tagout procedures. Critique members learned that in the February event, a construction manager initially walked down the system with subcontractor personnel and ensured that they were complying with the lockout/tagout procedures. However, he did not verify daily if subcontractor personnel were complying with lockout/tagout procedures and he did not verify compliance when the lockout/tagout was removed and then incorrectly reinstalled. The facility manager directed subcontractor personnel to stop draining the facility day tanks system until the site area director and DOE facility director agree on what corrective actions should be taken to ensure that draining of the system is safely performed. The facility manager directed facility personnel to improve subcontractor work control procedures.

NFS has reported in several Weekly Summaries events where systems or equipment were not locked out and tagged out. Following are some examples.

- Weekly Summary 99-06 reported that an operator at the Idaho National Engineering Environmental Laboratory Waste Experimental Reduction Facility

violated safe work permit requirements when he entered a mixed-waste incinerator chamber to remove hardened hearth ash from an ash hopper without a lockout or tagout. Although a safe work permit was in place for the work, it only permitted the operator to loosen the ash by reaching through an access hatch. (ORPS Report ID--LITC-WERF-1999-0002)

- Weekly Summary 98-49 reported that pipe fitters at the Rocky Flats Environmental Technology Site loosened a connection to bleed off residual air in an air supply line and realized that the line was still pressurized and not locked out or tagged out. Investigators determined that no one had performed a system walk-down to ensure all system isolation points were identified and locked out and tagged out before the pipe fitters began work. (ORPS Report RFO--KHLL-771OPS-1998-0048)

These events underscore the need for personnel to ensure that the lockout/tagout process is properly administered. Lockout/tagout holders should verify that the locks and tags have been correctly installed on the isolation boundaries. The Idaho events also illustrate the importance of having a questioning attitude. If the subcontractors had reviewed the lockout/tagout record sheets, they could have identified that the locks were on the wrong lockboxes.

Lockout/tagout programs in DOE serve two functions. The first function, defined in both 29 CFR 1910, *Occupational Safety and Health Standards*, and DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities*, is to protect personnel from injury and protect equipment from damage. The second function is to provide overall control of equipment and system status. The standard states that an effective lockout/tagout program requires three elements: (1) all affected personnel must understand the program, (2) the program must be applied uniformly in every job, and (3) the program must be respected by every worker and supervisor. A good lockout/tagout program is an important element of an effective conduct of operations program.

Facility managers are ultimately responsible for ensuring successful completion of work activities. Routine monitoring of contractor and subcontractor work by facility managers and supervisors will help ensure that maintenance activities are conducted in accordance with facility policy and procedures.

Facility managers, work planners, and crafts personnel should review the following references, which provide guidance and good practices for planning electrical work.

- DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities*, states that DOE policy is to operate DOE facilities in a manner to ensure an acceptable level of safety and that procedures are in place to control conduct of operations. Chapter VIII, "Control of Equipment and System Status," provides an overall perspective on control of equipment and system status. Specific applications of system control are addressed in chapter IX, "Lockout/Tagout," and chapter X, "Independent Verification."
- DOE-STD-1030-96, *Guide to Good Practices for Lockouts and Tagouts*, provides guidance on lockout/tagout program implementation and management at DOE facilities.

These events also highlight the need for comprehensive lessons learned programs. Article 5 provides additional information and references for lessons learned programs and discusses the relationship between a successful lessons learned program and an effective corrective action program. Article 4 provides additional lockout/tagout references and integrated safety management information.

KEYWORDS: conduct of operations, personnel error, procedures, subcontractor

FUNCTIONAL AREAS: Procedures, Industrial Safety, Hazards Analysis, Work Control, Licensing/Compliance

7. EMPTY DRUM PRESSURIZED BY ALTITUDE CHANGE

On January 28, 1999, at the Los Alamos National Laboratory Plutonium and Processing Facility, shipping/receiving employees were opening empty 55-gallon drums when the lid of one drum was forcibly ejected. The empty containers had been sealed and shipped from Oak Ridge (elevation approximately sea level) to Los Alamos (elevation 7,200 feet). The change in altitude caused the pressure in the drum to build up to approximately 3 psig. This event is significant because (1) pressurized drums can cause personnel injury from the sudden release of pressure or contents and (2) the lessons learned from previous similar events were not heeded. (ORPS Report ALO-LA-LANL-TA55-1999-0006)

The shipping containers are 55-gallon DOT Type 6L drums and, unlike other shipping containers in common use, are not vented. Laboratory personnel intended to use the drums to ship uranium and plutonium oxides or compounds back to Oak Ridge. Investigators determined that the employees opening the drums were using a special work permit because they only had experience with vented containers and were unfamiliar with the design of these drums. The special work permit did not caution that the drums could be pressurized or require the use of a lid-restraining device. Investigators also determined that the employees had already noticed slight pressurization in two other drums when they heard air escape as they opened them. An employee opening one drum assumed it was depressurized after hearing two releases of air from it. When the employee started to remove the retaining ring, residual pressure in the drum ejected the lid with enough force to propel it vertically almost 8 feet. Bags of vermiculite packaging material in the drum were also ejected. Another employee in the room then directed that the work stop. No workers were hit or injured by the ejected lid or packaging material.

After work stopped, the workers' supervisor recalled a similar event that occurred several years before this one, also at Los Alamos. The earlier event involved empty 55-gallon drums that also had been sealed at a lower elevation. In response to that event, facility personnel had obtained a safety device to restrain a drum's lid and allow internal air pressure to escape slowly before the lid was removed. The supervisor attempted to locate the safety device but was unsuccessful. Before work resumed for this event, the shipping/receiving team opening the drums rewrote the special work permit to require the use of clamps to contain the lids and allow the controlled release of pressure.

On May 17, 1995, at Grand Junction, the lid on a new 55-gallon drum blew off when a technician attempted to remove it. As in the Los Alamos events, investigators believed different ambient conditions at the location where the drum was sealed and the location where the drum was opened caused the pressurization. The corrective actions for the Grand Junction event follow. (Lessons Learned List Server Item Number 1995-AI-GEO-01)

- Evaluate existing drum handling procedures and revise as appropriate to require venting all new drums before use and to describe a safe method for doing so.
- Vent existing inventory of new drums according to revised procedures.
- Evaluate applicable training courses and revise as necessary to include warnings of possible drum pressurization.

- Treat all drums, including new drums, as if they are pressurized until vented and proven otherwise.
- Provide instructions to safely vent a drum that may be pressurized below the point at which it would bulge or otherwise deform.

NFS has reported other drum pressurization events in several Weekly Summaries. Following are some examples.

- Weekly Summary 98-21 reported that while an employee at the Idaho National Engineering and Environmental Laboratory was opening a 55-gallon drum, the lid was forcefully ejected because of internal pressurization. The lid brushed the face of the employee and hit the wall and ceiling of the cargo container in which the drum was stored. Investigators believed that water condensation may have reacted with granular depleted uranium oxides stored in the drum to generate gases that pressurized the drum. This Weekly Summary also contains figures that show a commercially available drum-lid-restraining device and a device to remotely vent pressurized drums. (ORPS Report ID- -LITC-SMC-1998-0004)
- Weekly Summary 98-10 reported that an inspector at the Idaho National Engineering and Environmental Laboratory found two bulging drums stored in a locked Resource Conservation and Recovery Act-compliant portable storage unit. Investigators believed the effect of anaerobiosis on septic wastes stored in the drums generated gases and pressurized the drums. A worker dressed in personal protective equipment, including a respirator, vented both drums by placing a specially designed net over the drums, loosening the lid ring bolts, and tapping the lids until gas could be heard escaping. (ORPS Report ID--LITC-CFA-1998-0002)
- Weekly Summary 97-03 reported that a hazardous waste worker was loosening a bolt on a 110-gallon drum ring at the Fernald Environmental Management Project when the lid blew off, striking the ceiling 14 feet above and coming to rest on the floor 3 feet away from the worker. (ORPS Report OH-FN-FDF-FEMP-1997-0003)

These events underscore the importance of recognizing the hazards that a pressurized drum presents to workers. Drum users should approach, handle, and open all closed drums as if they are pressurized. Lid-restraining safety devices should be routinely used to open closed drums. In the Idaho event, personnel were aware of the hazards presented by pressurized drums and took appropriate actions to vent them. Personnel also need to be aware that empty drums can become pressurized.

DOE/NS-0013, Safety Notice 93-1, *Fire, Explosion, and High-Pressure Hazards Associated with Waste Drums and Containers*, describes lessons learned on safe storage and handling of waste containers and drums. The notice specifically discusses handling, storing, venting, and opening containers suspected of being pressurized or containing flammable vapors. It can be obtained by contacting the ES&H Information Center, (800) 473-4375, or by writing to U.S. Department of Energy, ES&H Information Center, EH-72, 19901 Germantown Rd., Germantown, MD 20874.

KEYWORDS: pressurized drum, safety

FUNCTIONAL AREAS: Industrial Safety, Materials Handling/Storage

OEAF FOLLOW-UP ACTIVITY

1. OCCURRENCE REPORTING PROGRAM SURVEY

EH-33 has developed a survey to help determine how well its products and services meet the needs of its customers throughout the DOE complex. Besides the DOE and contractor organizations in the field that generate occurrence reports, customers include other organizations that rely on occurrence reports and the Occurrence Reporting and Processing System (ORPS) database for notification, analysis, and lessons learned. The objective of this survey is to get a big-picture look at the major elements of the DOE Occurrence Reporting Program from the customer's point of view. The survey includes the following elements.

- Occurrence Reporting Order/Manual
- ORPS database
- Occurrence Reporting Program home page
- ORPS Bulletin
- Occurrence Reporting Special Interest Group

Please note that this survey is intended for DOE and DOE contractors only, since ORPS access is limited to those groups. To help EH-33 determine what is and is not working well, please answer the survey by March 15, 1999.

The survey is provided as a pdf file that can be found as a new link on the Occurrence Reporting Program home page at <http://tis.eh.doe.gov/oeaf/orps.html>. You must have Adobe Acrobat Reader installed to open the file. If you are unable to open and print the survey, please contact Eugenia Boyle at phone number (301) 903-3393 or eugenia.boyle@eh.doe.gov. Instructions for completing and submitting the survey are included on the survey form. The responses will be compiled and the results published in the April ORPS Bulletin (also available from the Occurrence Reporting Program home page).